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ABSTRACT

Three studies examined the nature of individual differences and the role of advance information in reading comprehension. The subjects, 116 college students, read short passages--in some cases preceded by a given type of advance organizer--recalled the information therein, and finally sorted ideas from the passage into groups of similar ideas. Parameter estimates for the model of reading offered by Walter Kintsch and Teun A. Van Dijk, together with a derived measure for the idea-sorting task, showed that good readers were better than poor readers at recalling explicit propositions and organizing ideas, and that different types of advance organizers proved effective for the different types of readers. (Author/RL)

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Reading Comprehension: Techniques for Assessment and Optimization

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Reading Comprehension: Techniques
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In recent years, an increasing number of investigators (cf., Carroll & Maxwell, 1979; Cronbach & Snow, 1977) have focused on individual differences among learners, highlighting at once both the importance and the complexity of aptitude-by-treatment interaction (ATI) research. The current work focused on an examination of the nature of individual differences in one of the most important of these abilities, namely, reading comprehension. In particular, the studies to be reported represent an effort to extend this line of investigation in two ways. First, with the aid of two potentially powerful analytic techniques, it was hoped that certain of the differences between good and poor readers could be more exactly specified. Second, as a direct consequence of such specification it was anticipated that a means of text manipulation might be suggested that would reduce these differences by improving individual reading comprehension. Prior to detailing these experiments, the past research concerning individual differences in reading ability will first be reviewed in brief, then the main features of the analytic techniques employed in these studies will be summarized.

The nature of individual differences in reading has of course been the subject of empirical research for decades (cf. e.g., Buswell, 1920). At present, the evidence seems to indicate two probable factors

as the source of these differences: encoding efficiency and organizational ability (Golinkoff, 1975-1976). In terms of encoding efficiency, a number of researchers, including Fairbanks (1937), Katz and Wicklund (1971), and Perfetti and Hogaboam (1975), have shown that poor readers are generally much slower at verbalizing unfamiliar stimuli than good readers. Along similar lines, Perfetti and Goldman (1976) showed that good readers are superior to poor readers in the number of words they can recall from oral discourse, and Noelker and Schumsky (1973) found that good readers have better memory for the order in which items appear in prose material. Perfetti and Lesgold (1977) have reviewed a large number of experiments further substantiating the encoding differences between good and poor readers.

Another body of research has pointed to the difference in organizational ability between good and poor readers. Smiley, Oakley, Worthen, Campione, and Brown (Note 1) found that good readers not only recalled much more information from prose passages than poor readers, but also were more selective, displaying a larger difference between their recall of important and of less important information. Anderson and his colleagues, following Bartlett (1932) and others, have discussed differences in organization in terms of schemata, where schemata are defined as a specific type of knowledge structure that the reader brings to the text. Anderson, Reynolds, Schallert, and Goetz (1977) found, for example, that the interpretations given ambiguous passages were strongly related to the educational background of subjects (music vs. physical education), a finding interpreted as implying "that schemata can cause a

person to see a message in a certain way, without even considering alternative interpretations" (p. 367). Similarly, Voss and his associates (Spilich, Vesonder, Chiesi, & Voss, 1979; Chiesi, Spilich, & Voss, 1979) have examined the impact of differences in knowledge structures on discourse comprehension. In a representative study, Spilich et al. (1979) used descriptions of baseball games, since narratives concerning a particular game could be analyzed using a very well defined hierarchy of goals that the teams are trying to achieve. As predicted, high baseball knowledge individuals recalled more of a taped description of a portion of a game than low baseball knowledge subjects. In particular, high knowledge subjects recalled more goal-relevant information than low knowledge subjects and also recalled information in the appropriate order more often.

Believing, with Golinkoff (1975-1976, p. 629) "the purpose of reading to be comprehension (which may even occur in the skilled reader in the absence of the identification of each word)" our main focus in the studies reported below was on the reading comprehension process. We therefore concentrated our efforts on cognitive processes believed to underlie comprehension ability. Thus, to that end, techniques were required that would allow a detailed analysis of reader differences in the organization and general processing of prose material. Two such techniques were employed. The first involved the use of a recent model of reading comprehension which allows a determination of distinct parameters relating to different aspects of reading. The second incorporates a task derived by the authors for assessing directly the

organization of cognitive structures. These analytic techniques will now be described in greater detail.

A Model of Reading

Recently, Kintsch and van Dijk (1978) offered a model designed to describe mathematically the mental operations in the comprehension of entire prose passages and to predict how such comprehension is reflected in subsequent passage recall. The meaning of a text is initially represented in the model by an ordered listing of the simple ideas or propositions in the text, and three basic subprocesses are proposed, two related to comprehension and one to recall.

The first comprehension subprocess abstracts the microstructure of the text; that is, it forms a coherent or interrelated set of propositions corresponding as closely as possible to the ideal meaning. Due to the limited capacity of human memory, it is assumed that the text is processed in cycles, with some propositions being retained in short-term memory for subsequent cycles. The probability that a microproposition will be recalled later is p for each cycle it remains in short-term memory, or $1-(1-p)^k$ for k cycles.

The second comprehension subprocess produces of a macrostructure corresponding to the general meaning or gist of the passage. This is achieved by applying several macrorules (such as deleting, generalizing, or combining propositions) to the micropropositions. Recursive

application of these macrorules results in a hierarchy of macropropositions headed by a single macroproposition giving the essence or title of the article. Macroproposition recall is a function of the number of cycles the proposition is retained in the macrostructure being probability m for each cycle. The operation of the macrorules, is governed by the schema, a formal representation of the basic type and organization of information expected or desired from a given prose passage. Thus, a schema represents concepts as broad as "scientific report" or "story" by specifying the types and interrelationships of information that are key for that concept, and by containing variables or "blanks" that, when filled, result in an instantiation of the concept.

Finally, recall involves a sort of reversal of comprehension. Reverse macrorules are applied to macropropositions, resulting in access to stored micropropositions.

Although there are several variable features of the model (for a detailed description, see Kintsch & van Dijk, 1978), we were interested in it primarily as a framework within which to assess memory for details and memory for gist. For this reason, we allowed the two parameters which most directly reflect those aspects of recall (i.e., p and m) to vary, and assumed constant values for the other parameters. Memory for details is given by p and memory for gist is given by m. Values for the other parameters were chosen which were reasonable on both logical and empirical grounds. They were the same values as those used by Kintsch and van Dijk (1978).

Methodology for Assessing Cognitive Structures

As the review of previous research makes clear, the cognitive structure by which a body of knowledge is represented has emerged as an important aspect of the study of memory and the effects of instruction on memory. Several techniques have been developed to determine the cognitive structure of various domains, each relying on the use of matrices of proximity or distance between elements of the domain. The domains considered have been as diverse as physics (Preece, 1976), stories (Kintsch, 1977) and simple lists of unrelated words in a classical human learning experiment (Friendly, 1977). In most applications the elements whose structure has been sought have been individual terms, although Kintsch (1977) studied the structure of stories by treating paragraphs as elements. In a general summary, Shepard (1972) classified the different types of data that can be analyzed for structure; indicating both how such data can be obtained and which analyses are appropriate for each kind of data.

In our studies, subjects sorted cards, each of which contained a sentence stating an idea from the text, into groups of related ideas. The sroting data were used in two separate analyses designed to reveal the cognitive structure of the subjects. For one analysis, we determined the characteristics of a sort that was consistent with the ideal structure of the text. The ideal structure was defined as the

hierarchical organization in which the sentences are grouped into the sections or subsections of the article. Sections are determined by the schema appropriate for a given kind of passage. In this case a "scientific report" schema was assumed, with sections such as "introduction," "method," etc. The hierarchical structure based on this schema allowed two different ideal sorts to be made, which differed only in how coarse or fine they were. The fine sort contained smaller groups, which were subdivisions of the groups in the coarse sort.

The sorting done by subjects was then analyzed by computing the distance from each subject's sort to the closer of the two ideal sorts and treating that distance as the dependent measure in analyses of variance comparing groups of subjects. We defined the distance between two sorts as the number of pairs of sentences sorted into a common group in one sort and sorted into separate groups in the other. The distance from a subject's sort to the closest ideal sort was used so that the distance measure would not be sensitive to differences between subjects in how many groups they formed. Also, to standardize these measures, this distance is then divided by the number of possible pairs of propositions in the set, yielding a scaled distance measure which ranges from zero to one (see Boorman & Arabie, 1972, for a general discussion of measures of distance between sortings).

A second analysis of the sorting data was conducted to provide a visual representation of the cognitive structure of good and poor readers. This analysis, carried out only in the first experiment,

involved forming a measure of the similarity between sentences. The similarity between two sentences was defined as the number of times, across subjects, that the two sentences were sorted into the same group. Separate similarity matrices were formed for low ability and high ability readers. Each matrix was then used as input to a hierarchical clustering scheme (HCS) analysis (Johnson, 1967). HCS was chosen because it seemed likely to reveal the kind of hierarchical structure assumed to underlie subjects' organization of the text. Representing the formal structure of a text by a tree diagram is analogous to representing the grammatical structure of a sentence as a tree (Chomsky, 1972).

The analyses outlined above were conducted on the results of three experiments. No text manipulations were employed in the first experiment. It was conducted to perfect the methodology and to compare good and poor readers. The second and third experiments introduced various text adjuncts so that the effectiveness of these for good and poor readers could be ascertained. The adjuncts used, as well as the rationale for choosing them, will be more fully described in the introduction to each experiment.

With the two analytic tools, the Kintsch and van Dijk model and the propositional sorting task, it was believed that new and useful insights into the locus of individual differences in reading comprehension could be obtained and possible effective remediation strategies suggested. Such were the goals of the following experiments.

Experiment 1

The purposes of the first study were twofold: (1) to evaluate the general ability of the parameter estimation and structure assessment methodology, and (2) to determine the dimensions of processing along which high and low reading comprehenders differ.

Method

Subjects. Volunteer undergraduates from introductory psychology courses at the University of New Mexico were used. Eleven subjects from an initial sample of 127 were excluded because of experimenter error or failure to follow instructions, leaving a total of 116 subjects.

Materials. The standardized test used to assess reading ability was the McGraw-Hill Basic Skills Reading Test (Raygor, 1970), omitting the second part testing skimming skills. Two booklets were also given to the subjects. The first was labeled "Article Booklet" and contained the target passage. This passage was a 1300-word research report by Heussenstam (1971) called "Bumperstickers and the cops." The report summarized a simple psychology experiment but required no familiarity with experimental design or statistics. This report was used in the experiments reported by Kintsch and van Dijk (1978). The ideal structure of the article was defined by Kintsch and van Dijk in terms of the typical structure of research reports, including introduction, method, results and discussion sections and further subdivisions of

these sections. However, no headings indicating this structure were included in the article.

The second booklet given to subjects along with the "Article Booklet" was called "Answer Booklet" and contained instructions, two pages for subjects' free recall of the article information, and two pages concerning the card sorting task, one giving instructions for doing the task and the other providing instructions and space for recording the resulting sort.

The cards used in the sorting task were one inch by three and one-half inches in size and contained a typed statement on the front and a random two-digit number on the back. The statements used were chosen so as to give a representative sampling of the main higher-order ideas within each of the major subsections of the target passage. There was a total of 25 cards, hence 25 different statements, given to each subject for this task.

Procedure. Subjects were run in groups varying in size from 20 to 50 individuals. At the start of each session, each subject was given a copy of an Article Booklet and an Answer Booklet. Subjects were then instructed to read the article at their own pace, after which they were to go to the Answer Booklet for further instructions concerning what to do with the information in the article. The first page of the Answer Booklet asked subjects to recall as much of the article as they could remember, without referring back to the article. After recall, subjects

were told to go on to the card sorting task described on the next page. There they were told to arrange the cards contained in the nearby envelopes into groups of statements which were most closely interrelated in the article. They were then told how to record their sorting, which involved simply writing down the number on the back of each card and enclosing those sets of numbers placed in the same group in parentheses.

Finally, all subjects were administered the reading test as a means of classifying them into high and low reading ability groups. A median split on the total comprehension score was used to make this classification, with the data for the 11 subjects scoring at the median being omitted from the analysis comparing the reading groups.

Results

Propositional Scoring. In order to score the recall protocols, the target passage was broken down into each of its constituent propositions in accord with the system proposed by Kintsch (1974) and further detailed in Turner and Green (Note 2). As in Kintsch and van Dijk (1978), only the introductory material, that is, the material contained in the introduction section, was used for this purpose, it being assumed this provided an adequate sampling of subjects' behavior. A listing of these propositions, together with the relevant and irrelevant macropropositions derived therefrom, was made. Then each subject's recall was scored for the presence or absence of each of these propositions, the criterion being that the information be included, and not that the exact wording necessarily be used.

Parameter Estimates Recall protocols were analyzed in terms of the Kintsch and van Dijk model, both for the sample as a whole and for the comprehension groups separately. This involved using the STEPIT routine (Chandler, 1965) to perform a minimum chi-square estimation of the parameters of the model. Chi-square in this routine measures the discrepancy between the proportion of subjects recalling each proposition and the expected probability according to the model of that proposition being recalled. Results of these analyses are shown in Table 1. Since the g parameter seemed rather uninformative and has been excluded by others using the Kintsch and van Dijk model (i.e., Chiesi, Spilich, & Voss, 1979; Kintsch, Note 3), it was not included in the parameter estimation process. Thus, only the m and p parameters will be considered. The lack of fit of the model to the recall protocols of the entire sample, displayed in Table 1, was significant, X^2 (48) = 326.74.

Insert Table 1 About Here

Allowing the parameters to vary across the levels of comprehension ability indicated that, in terms of proportions, high and low comprehension groups differed greatly in the estimates of the p parameter (probability of recalling micropropositions) and somewhat less in the m parameter (probability of reproducing macropropositions).

In order to test the statistical significance of the differences in

individual parameters, a technique suggested by Neyman (1949) was employed. For each test, separate fits were made of one of the two parameters to each of the reading ability groups, holding the other equal to the value obtained when the two groups were treated as one. Then the difference was obtained between the resulting sum of X^2's for each of the groups with the single varying parameter and the (smaller) sum of X^2's obtained when both parameters were allowed to vary across groups. This provided a test of whether the constrained parameter also needed to vary across groups, with the difference in X^2s also having a X^2 distribution with degrees of freedom equal to the difference in number of parameters, which for comparisons in this study was one (i.e., 4-3). Thus, whether or not a given parameter differed significantly between two groups could be ascertained. For the current experiment, the test of the effect of reading ability on the $\underline{p}$ parameter was highly significant, X^2 (1) = 49.65, with the high comprehension group having a considerably larger $\underline{p}$ parameter than the low comprehension group. The high comprehension group also had a significantly larger $\underline{m}$ parameter, X^2 (1) = 7.79.

Sorting Task. The sorting of cards containing main ideas from the passage was first analyzed using Johnson's (1967) hierarchical clustering algorithm. The resulting product was a graphic indication of the way in which the two different groups of subjects tended on the average to organize the information. This produced some pictorial evidence of the differences between the groups (see Figure 1). The "relatedness" score for a cluster was computed from the proximity matrix

for the group of subjects. When the cluster contained only two sentences, the relatedness score simply indicates the number of subjects sorting that pair of sentences together, and thus ranges from 0 to the total number of subjects (51 and 54 for the low and high ability groups, respectively). When a new sentence is combined with an existing cluster, the relatedness score indicates the mean co-occurrence across pairs of sentences of the new sentences with the sentences previously in the cluster.

Insert Figure 1 about Here

Although the main structure of the article was apparent in the tree diagrams of both groups, this organization was "tighter" in the tree diagram of the good readers in that they correctly classified some ideas that poor readers generally misclassified. As an interesting example of this, note that sentence 24 which concerned a post hoc hypothesis about the findings of the study was consistently misclassified by low comprehension readers but correctly grouped by high comprehension readers (see Figure 1).

The sorting data were also used to determine if the groups differed in their distance from the ideal structure using the scaled distance measure described above. This measure provides the proportion of pairs of major ideas in the sorting task that were grouped in a manner inconsistent with the ideal organization of the ideas as components of a scientific report. The mean minimum distance of .161 for high ability

subjects was significantly lower than that of .219 for low ability subjects, $t(103) = 3.60$. Thus, in accord with the HCS results, the scaled distance analysis revealed that high reading comprehension subjects were able to sort the ideas into sets that were more consistent with the ideal structure than the sortings made by low comprehension subjects.

Discussion

This first investigation successfully demonstrated differences between low and high comprehension readers in both their memory for particular kinds of propositions and their cognitive organization of the text. This suggests that reading comprehension might be improved by remediation strategies aimed at either one of these aspects of prose processing. In fact, given that there are differences in organization between groups of differing reading ability, it could be the case that this is the factor of overriding importance. That is, a reader's ability to recall more detailed information may well depend on how effectively that information is organized. Therefore, in the next experiment, an attempt was made to enhance subjects' reading comprehension through the use of a text manipulation specifically designed to make the organizational structure of that text more apparent.

Experiment 2

The second experiment was designed primarily to enhance the reading comprehension of subjects, especially poor readers, by reducing the probable source of poor readers' comprehension deficit, namely, inadequate organizational ability. To achieve this end, a text adjunct was chosen which had in fact been proposed originally for precisely this purpose.

The particular adjunct chosen was the advance organizer. Ausubel (1963) first developed the advance organizer as a way of ensuring that meaningful learning occurs when a prose passage is read. Such learning requires the integration of new information with related, more abstract information already present as part of the learner's cognitive structure, and it is precisely the purpose of the advance organizer to serve this function by bridging the gap between old and new information. An advance organizer offers information prior to the main passage, generally in the form of one or more short prose paragraphs that contain key concepts related to those in the main passage, but at a higher level of abstraction, generality, and inclusiveness, and so explained as to be easily grasped by the reader. Advance organizers differ from summaries, according to Ausubel, in that the latter use concepts at the same level of abstraction as the ideas in the text itself, and achieve their shortened form solely through simplification and the elimination of less important information.

Experiments to assess the value of the advance organizer have yielded mixed results. The procedure generally used involves comparing the performance on a multiple choice test of a group reading an advance organizer prior to the target passage to that of a group receiving a different sort of introductory passage. Using this procedure, results supporting the superiority of the advance organizer group have been reported for target passages concerning a wide range of topics. (Allen, 1969; Anderson, 1973; Ausubel & Fitzgerald, 1961; Fitzgerald & Ausubel, 1963; Grotelueschen & Sjogren, 1968). Advance organizers in other than a prose format have also been shown to be facilitative. Advance information in the form of titles (Bransford & Johnson, 1972; Dooling & Mullet, 1973) and networks of technical terms (Earle, 1971) have also proven effective. However, a number of investigators using very similar paradigms have found no difference between groups (Jerrolds, 1967; Graber, Means & Johnston, 1972; Clawson & Barnes, 1973). The nature of the interaction of individual intellectual ability and organizer effects is similarly unclear. While some have found benefits only for the intellectually less able (Ausubel & Fitzgerald, 1962), others have reported more benefit for intellectually superior individuals (e.g., Grotelueschen & Sjogren, 1968).

The problem with advance organizer research taken as a whole arises from the failure to use sufficiently analytic tools to assess organizer effects. The second experiment, then, had two major aims. The first was to employ the Kintsch and van Dijk model and the sorting task to localize the effects of advance organizers and to determine the extent

to which those effects depend on the reading ability of the individual involved. The second, related aim was to optimize the comprehension of readers, especially those of lesser ability, through the use of the advance organizer.

Method

Subjects and Design. There were three groups differing in terms of the type of advance information received prior to the target passage: a control group which received no prior information, a control group which received a brief summary prior to the passage, and an advance organizer group which read a standard advance organizer prior to the passage. In addition, subjects within each group were divided into high and low reading ability groups based on their performance on a standardized reading test. The design was thus a 3 X 2 factorial (advance information by reading ability). Subjects were randomly assigned to advance information condition, 20 subjects being allocated to each for a total of 60 subjects, all undergraduate volunteers.

Materials. The reading test, sorting cards, and Answer and Article Booklets were essentially the same as those used in the first experiment, except that, for the purpose of generality, a different specific target article was chosen. The new article was entitled "The Mock Ward: A Study in Simulation" by Orlando (1973), and was also an informally written scientific report of roughly the same length as the article in Experiment 1.

Two types of prose paragraphs were constructed to precede the article. One type was a simple summary. This basically consisted of sentences which rephrased and shortened the main statements of the article, the resulting product looking much like a standard abstract. The second type was an advance organizer so constructed as to correspond closely to Ausubel's criteria. It contained definitions and explanations of the major concepts needed to understand the article, provided at a more general level than in the article but related to information the reader should already possess. Both types of advance information were printed on a separate page and were roughly 200 words in length.

Procedure. The procedure was basically the same as that of Experiment 1, subjects being given the reading test, then reading the Article Booklet, and finally doing the free recall of the article and the card sorting task. For subjects receiving the page containing advance information prior to the article, additional instructions on the page simply asked them to read the brief overview of the upcoming article and to be certain it was well understood before proceeding. In all other respects, the procedure was the same as in the first study.

Results

Parameter Estimates. The values of the p and m parameters for each of the different conditions of the experiment are shown in Figures 2 and 3. The Neyman (1949) technique was again applied to determine which

parameters significantly differentiated between groups.

Insert Figures 2 and 3 about here

Comparing high and low ability subjects, it was found that both the p parameter, X^2 (1) = 9.04, and the m parameter, X^2 (1) = 7.37, differed significantly, high ability subjects requiring larger values for both parameters. For low ability subjects, using similar tests, the conclusions regarding the effects of advance information were these. As is clear in Figure 2, there was no significant difference in the p parameter value obtained for the organizer group when compared to that of either the summary or control groups, nor did the p parameter value differ between the latter two groups. Similarly, for the m parameter (Figure 3), although the organizer group appeared to have a higher value than the summary group, the differences between conditions for low ability subjects were non-significant.

For high ability subjects, these were the main results. Regarding the p parameter (Figure 2), the summary led to a higher value than the control group, X^2 (1) = 9.00. The organizer resulted in a larger p parameter than either of the other groups, with tests showing the difference to be significant for the control group, X^2 (1) = 15.04, but not for the summary group, X^2 (1) = 2.06. For the m parameter (Figure 3), the summary group actually required a lesser value than the control group, with X^2 (1) = 4.62. The organizer group yielded an m parameter intermediate between those for the control group and the summary group,

with statistical tests of the differences being inconclusive. Thus, overall the statistical tests support the impressions suggested by Figures 2 and 3 regarding the parametric differences between groups. Namely, for low ability subjects these text adjuncts did not have a great impact on processing, at least not as that is reflected in the model parameters. The one hint of an exception was that there was a trend for the m parameter to be higher in the organizer group. For high ability subjects, the text adjuncts clearly increased p, but if anything lowered m.

For the model taken as a whole, using all subjects combined, the X^2 for the difference between predicted and obtained recall propositions was X^2 (48) = 222.44, which is naturally significant, indicating a lack of complete congruity between the predictions of the model and the obtained data. The X^2's were also significant for each of the groups considered separately: for the control group, X^2 (48) = 80.04; for the summary group, X^2 (48) = 97.35; and for the advance organizer group, X^2 (48) = 94.05.

Sorting Task. Since it was felt that the tree structures yielded by the HCS method would be rather noninformative in a situation as complex as this, only the scaled distance scores are presented for this task. The results of this analysis are shown in Figure 4. An analysis of variance using the factors of advance information and reading ability showed no significant effects of either factor on the distance measure. However, a t-test did reveal that high reading ability subjects sorted

better when given the advance organizer than when given no advance information, $t(8) = 2.071$.

Insert Figure 4 about Here

Discussion

Three conclusions are warranted from the results of this second experiment. First, as was the case in the first experiment, good readers differ from poor readers in their ability to abstract both detailed information (p parameter) and more general gist information (m parameter). Second, advance organizers are of some benefit, e.g., in improving the ability of good readers to abstract details and to grasp the organization of the article, but the facilitating effect for low ability subjects was not as marked here as had been hoped. Third, as Ausubel (1963) has contended, there was a suggestion that simple summaries are not as effective as advance organizers in facilitating prose comprehension and retention. In fact, good readers showed some decrements in their m parameter values as a result of encountering the summary.

Two points within these results led to the design of the third experiment. The fact that there was some evidence that advance organizers enhance recall is at least consistent with the hypothesis that the organizer may be providing subjects with a well-defined schema

needed to easily process the following information and evaluate it for its important elements. Also, the fact that for low ability subjects only the m parameter was affected argues that it might be possible to construct an organizer which is even more helpful to the poor reader. These two points determined the specific questions which the third experiment was designed to address.

Experiment 3

The main purpose of the third experiment was to construct and test an advance organizer that would be of even more benefit to the poor reader than the standard organizer had proven to be. The advance organizer so constructed was one directly implied by the Kintsch and van Dijk model. Thus, the new organizer was so structured as to provide subjects with the necessary ideal schema, according to the model, for interpreting scientific reports. That is, the organizer showed the main divisions of scientific reports and their essential contents, exactly as described in Kintsch and van Dijk (1978). In order to assure that less able readers could derive maximum benefit therefrom, this organizer was translated from prose into diagrammatic form, and the specific form of the organizer thus constituted a separate experimental condition. The assumption was that suffering from some reading deficit, poor readers might in fact be less able to benefit from an organizer in prose format than from a more pictorial presentation which relied less on the reading process in order to be understood. Hence, they might benefit even more

when this "schema" organizer is put in a more pictorial form. Finally, in the hope of even further maximizing the advance organizer effects, conditions were included in which the target article contained appropriate subheadings in line with the ideal schema. Although most past research indicated little benefit of headings (cf. Christinasen & Stordahl, 1955; Hershberg & Terry, 1956; Coles & Foster, 1975; Cole, 1977), it was hoped that they might prove beneficial when used in conjunction with an explicit organizing plan. Being told the most important information contained in each main division of a scientific report through the advance organizer, subjects might show even more improvement in comprehension if, within the text itself, those major divisions were indicated.

Method

Subjects and Design. Twenty subjects were assigned to receive an advance organizer in paragraph form and 20 to receive the organizer in diagrammatic form. Within each of these organizer groups, half of the subjects were given target passages containing subheadings while half had passages without such subheadings. In addition, subjects within each group were divided on the basis of reading test results into high and low reading ability groups. There was also a control group of ten subjects which received no advance organizer or information of any type. The total of 50 subjects was drawn from the same population as those in the first experiment, although this experiment occurred during the summer session, while the others had taken place during the regular school year.

Materials. The reading test was again the same as that used in the earlier experiments, as were the Article Booklet and Answer Booklet. The specific article, Article Booklet, Answer Booklet and cards were identical to those in the first experiment, with the exception that for some subjects the article contained subheadings corresponding to the main divisions within a scientific report according to the ideal schema, namely, Introduction, Method (broken down further into Subjects and Procedure), Results, and Discussion. Two different forms of advance organizers were constructed, designed to convey essentially identical information but in two different formats. The prose organizer was a paragraph of approximately 250 words describing the major subdivisions of a scientific report and what each, ideally, should contain. Thus, the Introduction was described as the section which sets forth the main problem addressed by the study and does so by reviewing relevant past literature and events, describing the setting of the experiment in terms of location and time, and defining the main purpose of the experiment. Similar discussion was provided for each of the other major sections. For the diagram organizer, the same information was presented, but in the form of summary words or phrases connected in meaningful ways so as to indicate the main contents and interrelations of the various sections. Instructions in the "Article Booklet" told subjects that the organizer described the general features of scientific reports, and that after studying the organizer they would be reading a specific scientific report, but without being allowed to refer back to the organizer.

Procedure. Subjects were run in groups of five to ten individuals. Roughly one-fifth of the subjects in each group received "Article Booklets" containing no organizer and no subheadings. The others were equally divided among four groups: prose organizer, headings; prose organizer, no headings; diagram organizer, headings; diagram organizer, no headings. In all other respects, the details of the procedure were the same as those used in the first experiment.

Results

Parameter Estimates. The main analyses were concerned with the parameters of the Kintsch and van Dijk model and their variation across differing groups. The parameter values obtained for the three organizer conditions are presented in Figures 5 and 6, separated according to the p and m parameters. For clarity of presentation, in the figures we have collapsed across levels of the heading factor, but will enumerate the effects of headings below.

Insert Figures 5 and 6 about Here

A number of trends are indicated in the figures, In terms of reading ability, the p parameter assumed a larger value for good readers, i.e., a significantly better fit was obtained when the parameter was allowed to vary across levels of reading ability X^2 (1) = 11.83. The m parameter did not need to vary across ability groups.

Turning first to the high ability readers, the major conclusions were these. The presence of headings debilitated performance as reflected in both smaller m and smaller p parameters, X^2 (1) = 4.44 and X^2 (1) = 6.52, respectively. The prose organizer raised the p parameter, X^2 (1) = 9.17, but lowered the m parameter, X^2 (1) = 5.38, relative to the control group receiving no advance organizer. The diagram organizer also raised p, X^2 (1) = 9.26, although m was not significantly affected.

For low ability readers, the pattern was somewhat different. The presence of headings did not affect either parameter. The prose organizer produced a rise in p, X^2 (1) = 16.18, but not m. The same was true for the diagram organizer, with X^2 (1) = 17.46 for p.

Regarding the model as a whole, the X^2 for the difference between predicted and obtained recall propositions was again significant, X^2 (48) = 175.78, as were the X^2's for the many different groups.

Card Sorting. The analysis of the card sorting task to yield scaled distance scores is shown in Figure 7. Analyses of variance were performed on the resulting dependent variable.

Insert Figure 7 about here

When all subjects including the control group were combined, the

only significant effect was that of reading ability, good readers sorting better than poorer readers, $F(1,44) = 10.77$, MSe = .0062. Looking just at the organizer groups, there was again a significant effect of ability, with good readers the better card sorters, $F(1,32) = 6.83$, MSe = .0044. There was also an interaction of type of advance organizer and headings; low ability subjects given diagram organizers generally performed the sorting task better when headings were also provided, while those given the prose organizer did better on the task when no headings were included in the article, $F(1,32) = 5.21$, MSe = .044.

Discussion

The overall pattern of results in the third experiment prompts three major conclusions. First, high ability readers were shown to be superior in their recall of detailed information, and were also better able to organize the abstracted information, as shown in the lower distance scores on the card sorting task. Second, the inclusion of headings generally had a detrimental effect with the current materials and measures. It may be that headings are beneficial only for longer passages. Finally, it is necessary to consider the relative effectiveness of the two types of organizers used in this experiment. Regarding the question of format, the overall effects of both prose and diagram organizers seem to be similar. Both facilitated performance relative to controls, particularly for low ability subjects and for recall of micropropositions. As concerns the relative effectiveness of

this organizer type when compared to that used in the second experiment, the results are mixed. As hoped, the poorer readers were in fact better assisted by the schema-like organizer used in Experiment 3 than by the text adjuncts used in Experiment 2. For high ability subjects, the ability to abstract details was increased by the organizer in both experiments, but the m parameter tended to decline.

General Discussion

The original goals of this research were two in number: first, to use several new analytic techniques to localize the nature of the differences between good and poor comprehenders; and second, to optimize the reading comprehension of readers through the use of a text manipulation specifically geared toward the indicated differences. It will now be useful to evaluate the extent to which these goals were attained.

The first goal was achieved with fair success. The parameters derived from the Kintsch and van Dijk model showed poor readers' lack in their ability to recall both general and more specific information. The scaled distance scores calculated from the results of the sorting task clearly indicated that good readers do a better job of organizing prose information in accord with the underlying ideal structure of that information than do poor readers. Together, these measures point to an organizational deficit in poor readers as a probable major cause of their inferior comprehension.

In regard to the second goal, facilitating prose comprehension through an appropriate text manipulation, this seems also to have been fairly well met. The standard organizer proposed by Ausubel (1963) was somewhat effective in enhancing the ability of poor readers to abstract and retain general information, but was clearly more beneficial for good

readers, aiding in particular their recall of detailed information. When a new organizer was tried in the third experiment, one which provided subjects with the general ideal schema prior to the introduction of the appropriate passage, this was shown to be particularly helpful for the poor reader. There was a marked improvement in the ability of these readers to recall detailed information. For good readers though, this form of organizer was not found to be nearly as beneficial. While it seemed to assist their recall of detail, it actually decreased their ability to recall more general ideas.

Thus, in broad terms, the advance organizer was found to be a useful text adjunct, with the facilitative effects dependent on the specific type of the organizer and the general reading ability of the subjects involved. Poor readers seem to profit most when the advance organizer gives them a plan for organizing the subsequent information and for assessing its relative importance. In terms of past individual differences research, this seems logical. Such an organizer should not only overcome some of the poorer readers' organizational deficits, but should also help compensate for the double deficit (Perfetti & Lesgold, 1977) suffered by such readers due to slower encoding ability. Part of that deficit stems from the fact that poorer readers cannot process text words rapidly enough to determine the appropriate schema needed for their interpretation. This particular organizer bypasses that problem by providing the reader with the schema at the start, and so part of the deficit associated with slower word encoding and slower schema access is overcome.

Good readers, on the other hand, do best when given the concepts needed to understand the passage. Such readers probably already possess fairly well defined schemata for interpreting such general prose passage types as scientific reports, and hence derive little of value from the schema type of organizer. They may even be adversely affected when confronted with a specific schema that differs in certain ways from their own, at least in terms of their recall of more general information. What they lack instead is a clear understanding of some of the newer, more abstract concepts used in a specific text, and hence being provided with a precise specification and examples of those concepts is more helpful. Needless to say, the effectiveness of this more standard type of advance organizer must naturally depend on the particular key concepts needed to interpret a given text and the unique background of the readers involved.

The conclusions derivable from this research, then, would include the following major points. Evaluating the types of information recalled from prose and the way such information is organized provides much insight into the nature of individual differences in text processing. The techniques suggested by this paper for such analyses proved adequate to the task, and both scaled distance scoring and process parameterization should be considered by those doing research in this area. Furthermore, a specific deficit was found for poor readers, that deficit being an inability to optimally organize prose information.

This deficit was substantially reduced through the use of an advance organizer which made the passage organization more explicit. It would seem worthwhile to pursue additional means of optimizing comprehension through the enhancement of organizational abstraction. Finally, it seems significant that text manipulations which benefically affected poor readers actually had some detrimental consequences for good readers. This serves as a reminder that one must constantly be aware of the need to tailor text manipulations in a precise way to the target population of concern.

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TABLE 1

Estimates of Parameters of the Comprehension Model in Experiment 1

Group	Paremeter		χ^2
	m	p	
All Subjects	.175	.067	326.74
High Comprehension	.200	.095	184.69
Low Comprehension	.150	.043	135.34

Figure Captions

Figure 1. Hierarchical clustering of sorting data for low comprehension readers (Panel A) and high comprehension readers (Panel B) in Experiment 1. Sentences are numbered in accord with the order in which ideas were presented in the article. Sentences 1 through 4 pertain to the introduction of the article, 5 through 14 to the method, 15 through 18 to the results, and 19 through 25 to the discussion. See text for explanation of "Relatedness" scores.

Figure 2. Obtained p parameter values as a function of reading ability and type of advance information in Experiment II.

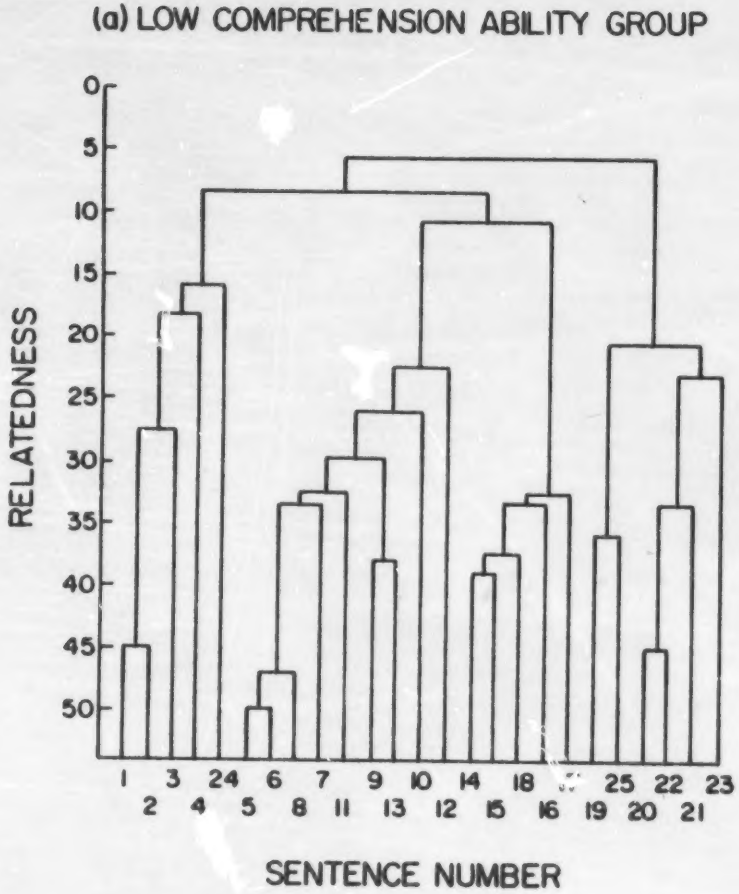
Figure 3. Obtained m parameter values as a function of reading ability and type of advance information in Experiment II.

Figure 4. Mean distance scores for card sorting task as a function of reading ability and type of advance information in Experiment II.

Figure 5. Obtained p parameter values as a function of reading ability and type of advance information in Experiment III.

Figure 6. Obtained m parameter values as a function of reading ability and type of advance information in Experiment III.

Figure 7. Mean distance scores for card sorting task as a function of reading ability and type of advance information in Experiment III.


(a) LOW COMPREHENSION ABILITY GROUP
RELATEDNESS
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5
10
15
20
25
30
35
40
45
50
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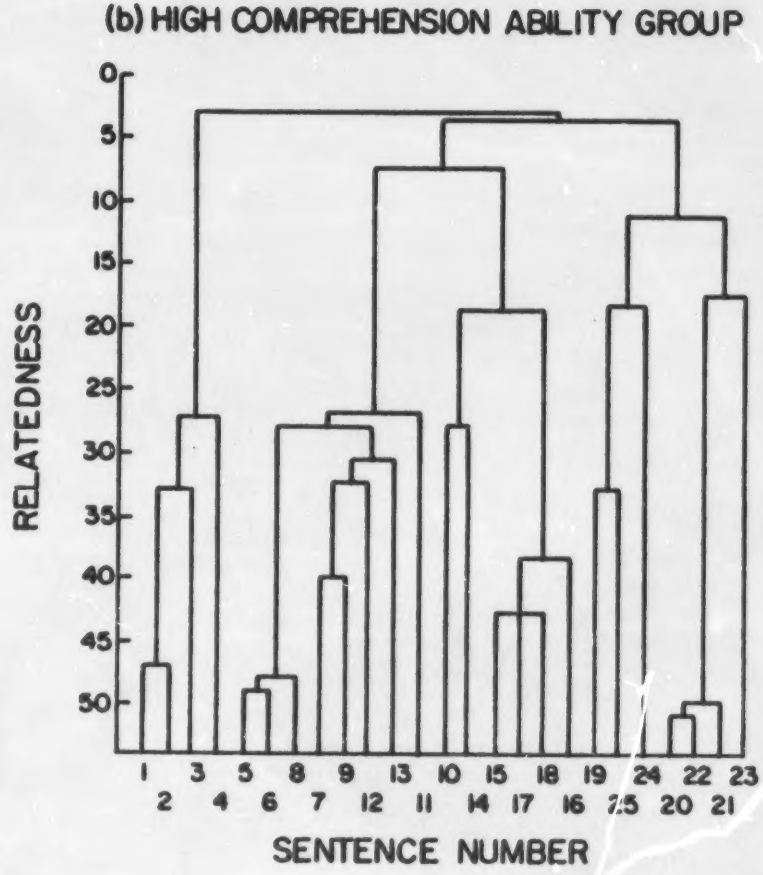
2 4 5 8 11 13 12 15 16 19 20 21
SENTENCE NUMBER


(b) HIGH COMPREHENSION ABILITY GROUP
RELATEDNESS
0
5
10
15
20
25
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35
40
45
50
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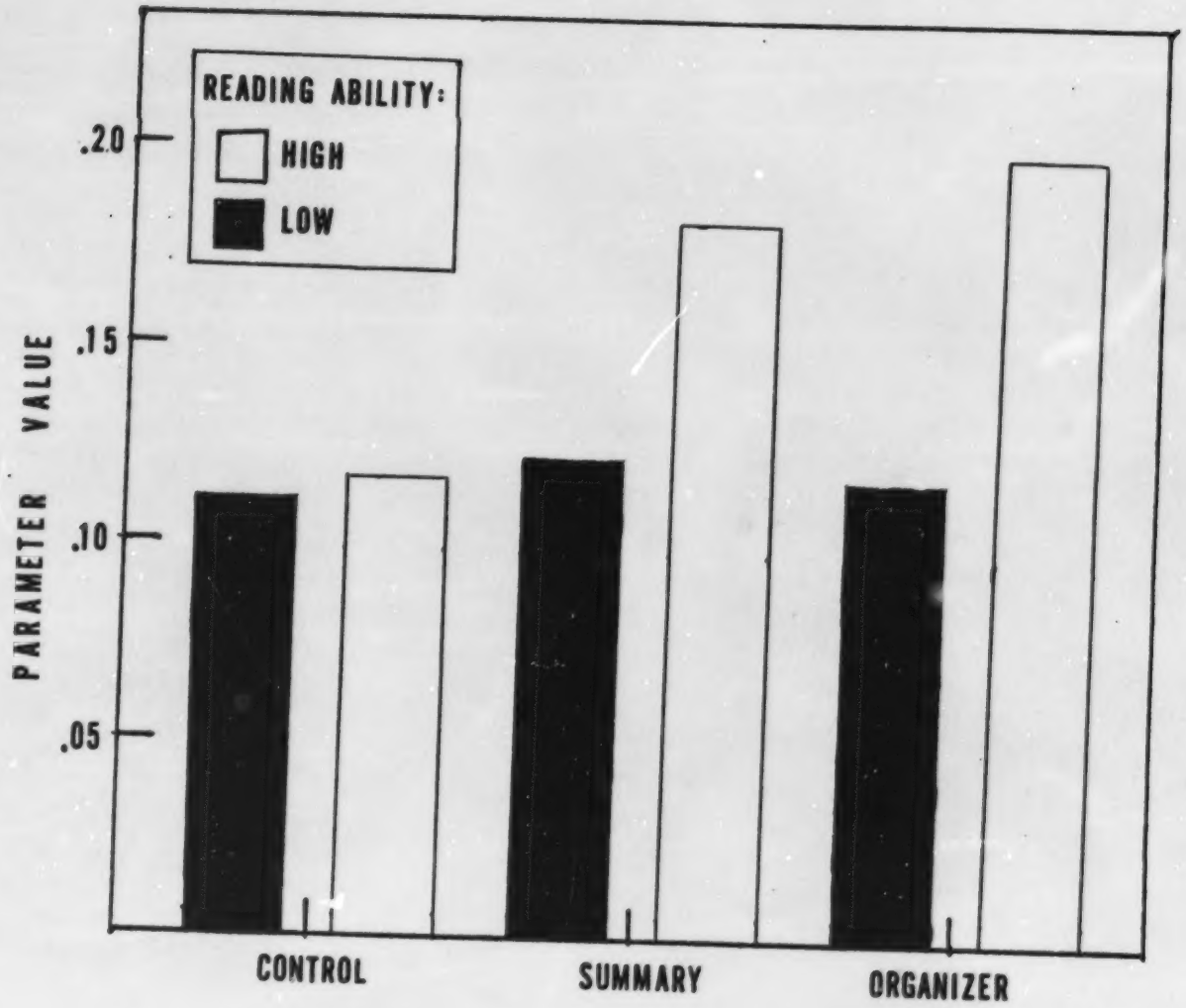
2 4 6 7 12 11 14 17 16 21 20 21
SENTENCE NUMBER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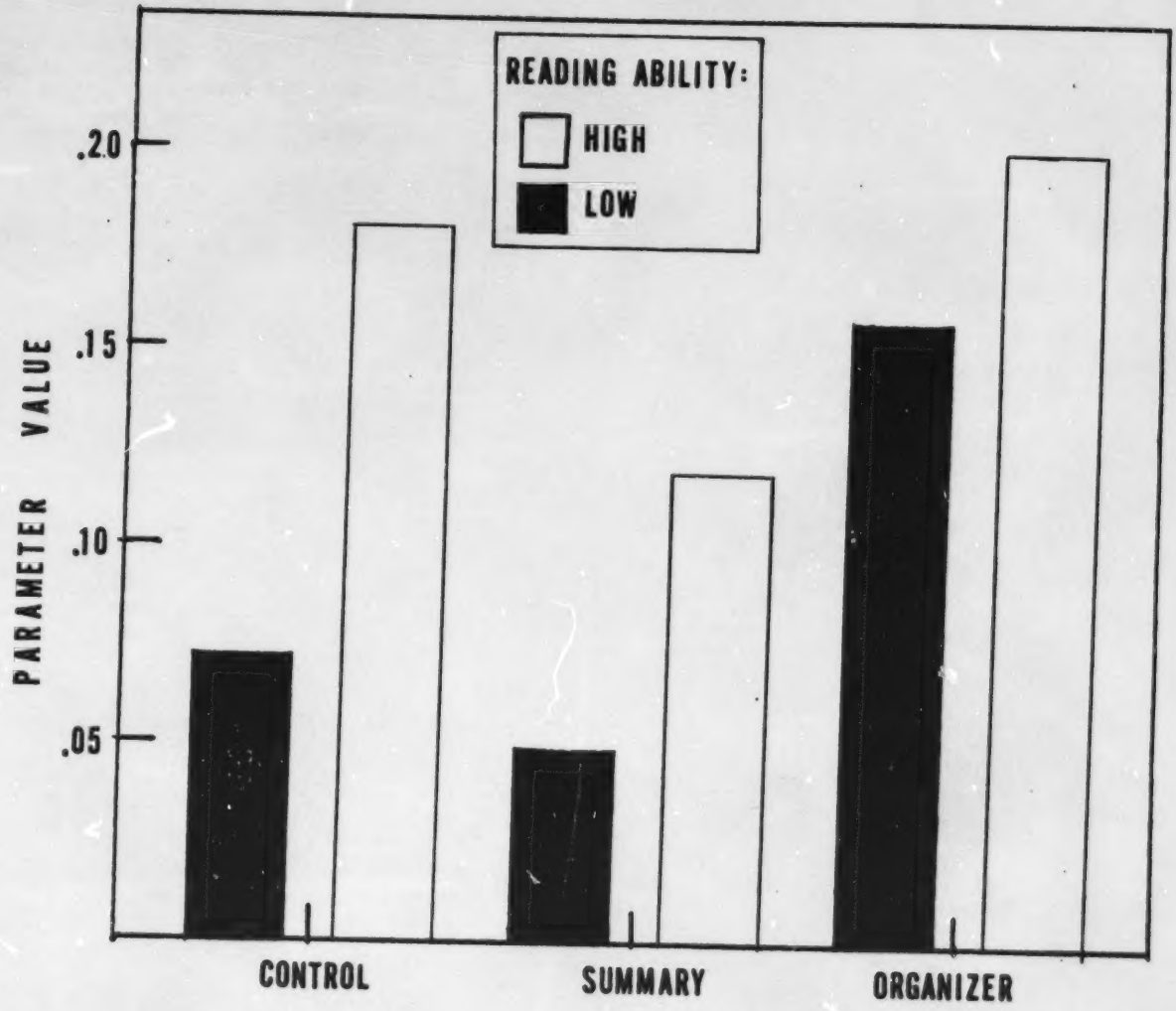
PARAMETER VALUE
CONTROL
SUMMARY
ORGANIZER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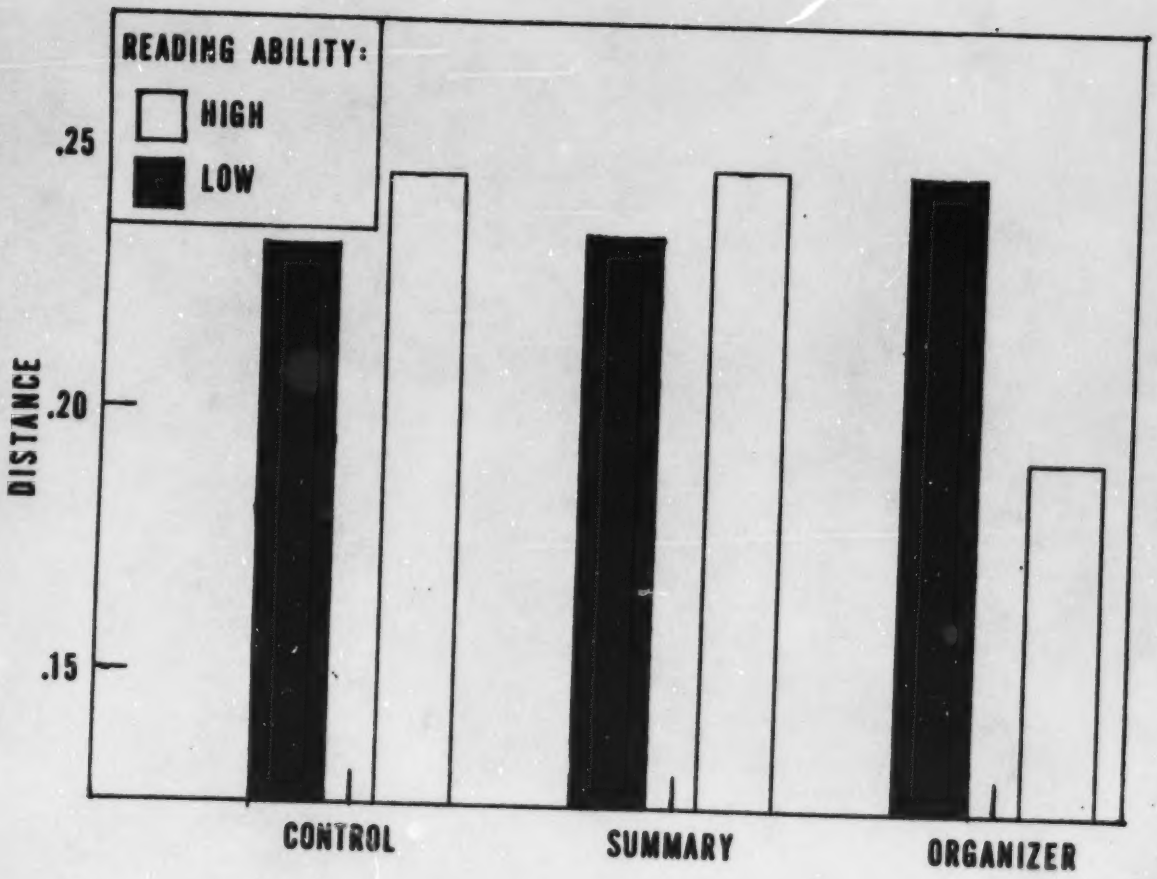
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SUMMARY
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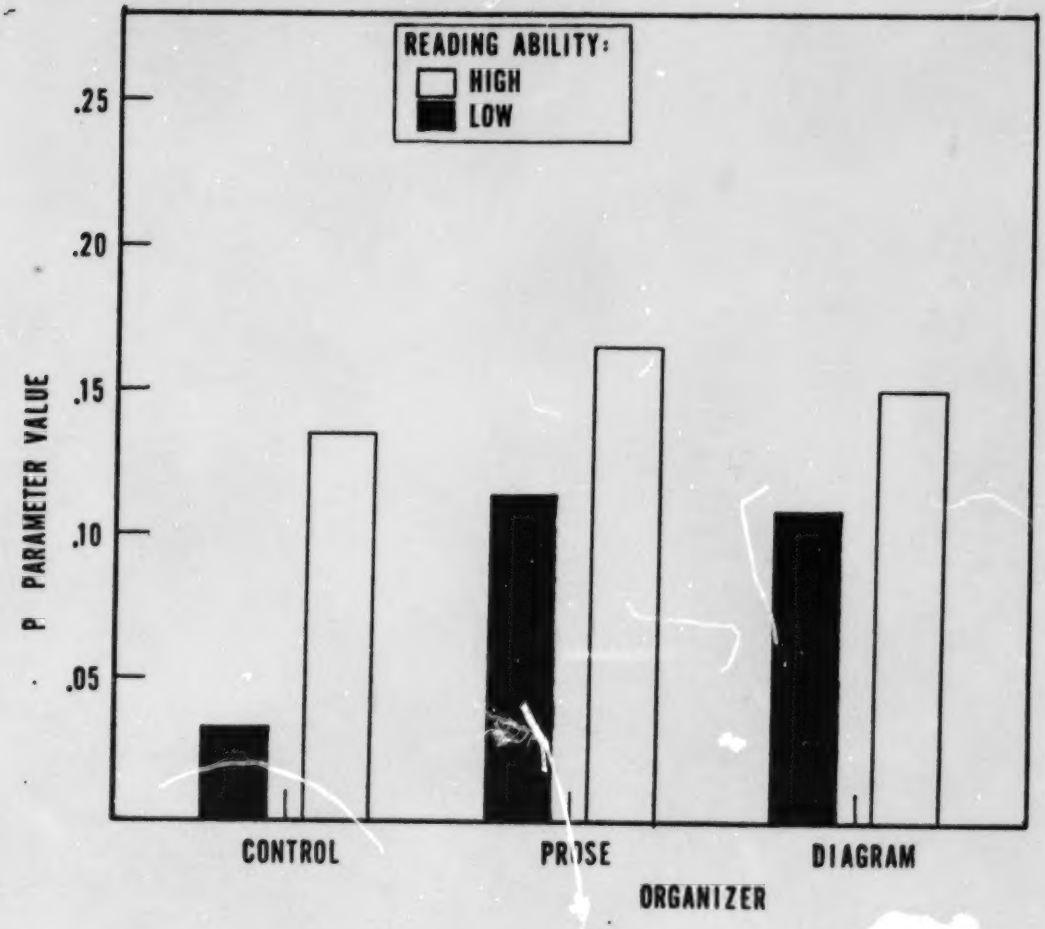
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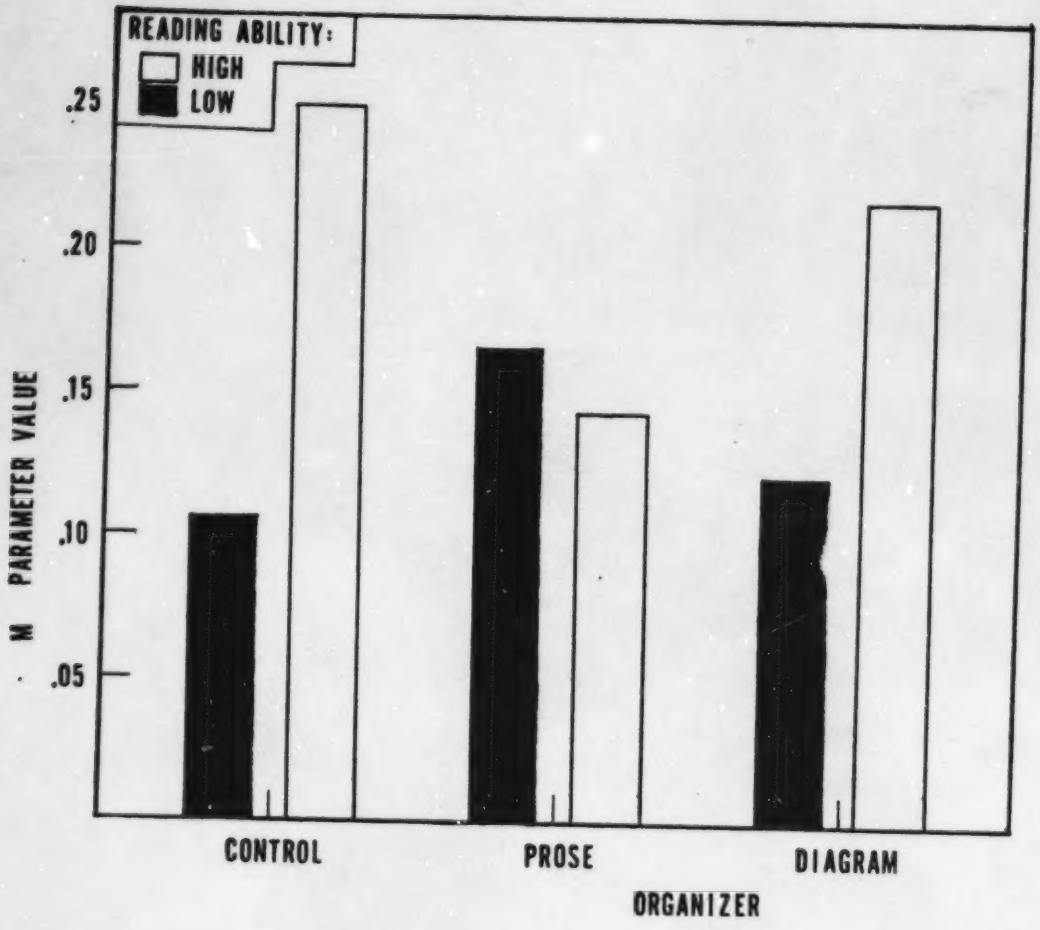
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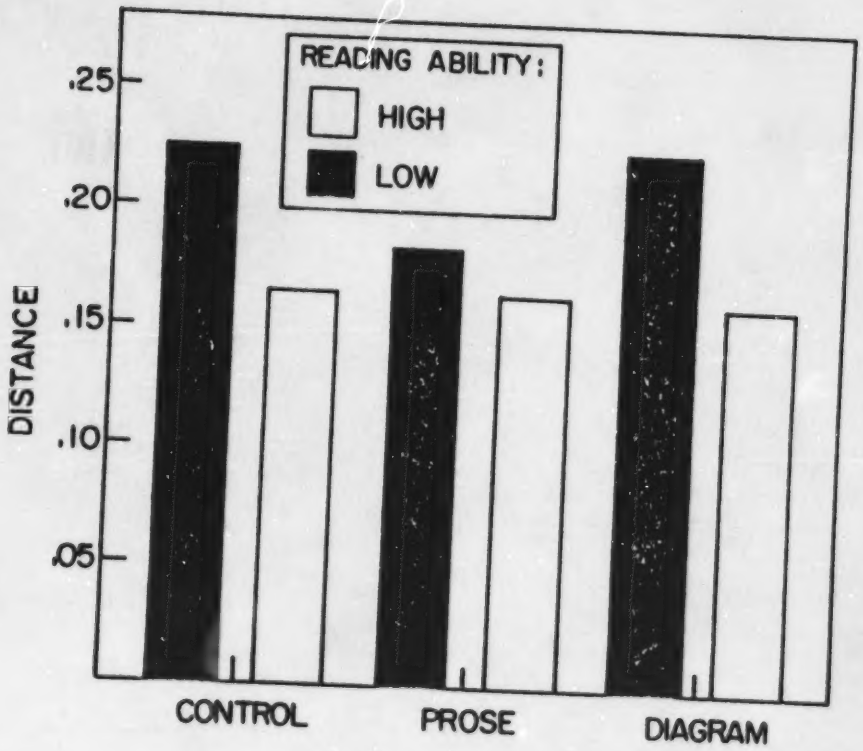
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